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Overview and Current Status of WEPS 1.0

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Introduction

The Wind Erosion Prediction System (WEPS) is a process-based, daily time-step, computer model that predicts soil erosion by wind via simulation of the physical processes controlling wind erosion. It is intended to replace the predominately empirical Wind Erosion Equation (WEQ) (Woodruff and Siddoway, 1965) as a prediction tool for planning soil conservation systems, conducting environmental planning, or assessing off-site impacts caused by wind erosion. WEPS incorporates improved technology for computing soil loss by wind from agricultural fields. It also provides additional capabilities not present in WEQ such as separate calculation and reporting of creep/saltation size particles, suspension loss, and PM-10 emission estimates from the field (Wagner, 1996).

WEPS 1.0 is the first implementation of WEPS to be released and includes a graphical user interface to simplify use of the model. WEPS 1.0 implements a subset of all the features and capabilities originally envisioned for WEPS. However, it still includes the daily time-step organizational structure, input databases, process-based erosion prediction technology, as well as most other key elements advertised for WEPS in the past. Since the United States Department of Agriculture, Natural Resource Conservation Service (USDA-NRCS) is expected to be one of the primary users of this release, the mix of features in WEPS 1.0 was determined based upon their current primary needs. Future releases of WEPS are projected to include additional functionality and other capabilities as customer demand dictates. It is expected that users trained in the use of WEPS 1.0 will find their knowledge, databases, management/crop rotation files, etc. for WEPS 1.0 to be directly transferable to future versions of WEPS.

Background

Soil erosion by wind is a surface phenomenon. It is initiated when the wind speed exceeds the threshold for a given soil and its surface condition. After initiation, the duration and severity of an erosion event depend on the wind speed and the evolution of that surface condition. Therefore, WEPS requires wind speed and direction to simulate the erosion process. These and other weather variables are used in WEPS to drive temporal changes in hydrology, soil erodibility, crop growth, and residue decomposition. WEPS tracks changes in the current soil state and surface condition within the model due to these weather driven processes. Stochastic climate generators, WINDGEN (Skidmore and Tatarko, 1990) and CLIGEN (Nicks et al., 1987), are used to provide WEPS with the necessary daily weather data and subdaily wind information. The simulation region in WEPS is a field or, at most, a few adjacent fields. Areas of the simulation region that have differing soil, management, or cropping conditions are treated as separate subregions. WEPS can output soil loss/deposition over user-selected time intervals from user-specified accounting regions within the simulation region. This allows the WEPS user to obtain output over various spatial scales within the simulation region. WEPS also provides users with individual soil-loss components of creep/saltation, suspension, and PM10 size fractions. These components are particularly useful as an aid in estimating off-site impacts of wind erosion.

WEPS 1.0

WEPS 1.0 is the first public release of WEPS. To meet NRCS's immediate needs for improved capabilities of wind erosion prediction; to allow other users earlier access to WEPS technology; and to facilitate getting that first product "out the door", it was necessary to limit the scope of what WEPS 1.0 would do. Thus, the following design decisions were made:

1) WEPS 1.0 would be released with a graphical user interface to assist users in making WEPS simulation runs. For NRCS users to apply WEPS in the manner expected, they would need to be able to select and modify inputs quickly and easily. Likewise, users want the output presented in a convenient form that is easy to interpret.
2) WEPS 1.0 would use the full WEPS core science model. No separate, "scaled down" version of the WEPS simulation code would be developed. As the WEPS science code evolves, WEPS 1.0 would continue to use the "latest" version of that code. This approach ensures that WEPS 1.0 will benefit from bug fixes and simulation enhancements in the WEPS science code.
3) WEPS 1.0 would handle a single homogeneous subregion, i.e., the simulation region would be represented by only one soil type and management/crop rotation sequence. This allows the WEPS 1.0 developers to focus on the core physical simulation processes in WEPS and not the code to handle multiple subregions.
4) WEPS 1.0 would have only one defined accounting region, the entire simulation field. Because only one subregion is used, the need for additional accounting regions would be limited. This approach also reduces the number of potential output options with which a user is confronted.
5) WEPS 1.0 would provide a limited selection of time scales for output reports: a) half-month period averages per rotation year; b) monthly averages per rotation year; c) rotation year averages; d) long-term yearly averages; and e) yearly results for a few selected data, such as crop harvest yields.
6) WEPS 1.0 would use the same soil, plant growth, management operation, and climate databases to be used in future WEPS releases. Planning for this level of compatibility with future versions of WEPS should make it easier for WEPS users to upgrade to later, more functional, WEPS releases.
7) WEPS 1.0 would limit wind barrier placement to field boundaries only. This would simplify the graphical user interface code for placing and displaying wind barriers. Also, because WEPS 1.0 would deal with only a single subregion, placing barriers within the simulation region would be of limited benefit.

User Interface

WEPS 1.0 requires the following user input selections to perform a simulation run: 1) site location, which determines the appropriate weather station data records to be used by the climate generators; 2) rectangular site dimensions and orientation with respect to North; 3) dominate soil type; 4) management/crop rotation practices applied to the field; and 5) any wind barriers along the field boundaries (optional). The objective of the graphical user interface is to provide an easy way for a user to make those input selections via choice lists from databases and pre-built templates. The interface also gives users the ability to modify individual input parameter
values for any given simulation run. In addition, the user interface provides a convenient method to select and view desired WEPS output information. The most current beta versions of WEPS are available for download from: http://www.weru.ksu.edu/weps

Current WEPS 1.0 Status

To facilitate feedback to the WEPS development team, training sessions were conducted with NRCS state and regional level specialists across the country. It became obvious from those workshops, NRCS would require a well tested science model and a robust user interface designed to simplify use of the model. Also, the need for fully populated and quality reviewed national level soil, plant, and management operation databases would be required for NRCS field office use of WEPS 1.0. The identified deficiencies in the science model, interface, and databases were documented and are currently being addressed.

In addition, to help ensure that the final release of WEPS 1.0 comes to fruition, WERU has developed a formal Agreement to be signed by ARS and NRCS. The Agreement stipulates what features will be included in WEPS 1.0 and what capabilities will not by the scheduled delivery date to NRCS of June 30, 2003. The specific tasks addressing all documented deficiencies and missing features required by NRCS for WEPS 1.0 have been enumerated and a timeline schedule outlining the work to be completed are included in the Agreement. Currently, work is progressing based upon the tasks outlined in the Agreement. A copy of the most recent version of the Agreement is accessible at: http://www.weru.ksu.edu/weps/Agreement/Agreement.pdf

WEPS 2.0

In the future, WEPS will better represent spatially the effects of varying terrain, changing soil types, wind barriers, strip-cropping systems, ridge till, contour-farming practices, and emergency tillage on wind erosion. In addition, WEPS will be expected to more accurately estimate the potential offsite effects of wind erosion on air and water quality, roadside visibility and possible health consequences. To do so, the following capabilities will need to become available in subsequent versions of WEPS:

1) The ability to simulate more complex sites, which consist of two or more dominant soil types and possibly have different management practices applied to specific areas within the field site. This will be handled in WEPS through the use

of multiple subregions or areas representing a single soil type and set of management practices.

2) The ability to specify elevation variations to describe the simulation region terrain more accurately and to better describe deviations in ridge and row directions that are due to the topography and/or shape of the field (contour farming practices and tilling parallel with field boundaries).
3) The ability to handle more advanced wind barriers (those with seasonal changes in height and silhouette area) and erosion traps (regions that are considered to only “collect” moving soil and not be potential transmission sources, e.g. ponds, grass waterways, road ditches) and have them placed anywhere within the simulation region.

Summary

WEPS is a process-based, daily time-step, computer model that predicts soil erosion via simulation of the physical processes controlling wind erosion. WEPS 1.0 is the first implementation of WEPS for use by the USDA-NRCS and is intended primarily for soil conservation and environmental planning. It includes a graphical user interface to allow the user to easily select climate stations, specify field-site dimensions, pick a predominant soil type, and describe any border field wind barriers and management practices applied to an agricultural field.

References

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